SIGNIFICANT FIGURES, CALCULATIONS, AND READING MEASUREMENTS LAB

Purpose: At the core of all science is the ability to take accurate and precise measurements and to do
calculations. Central to these concepts are significant figures, because they help tell us how good measurements are. In this lab you will gain experience with all of these concepts.

Background: You are going to need some background to do this experiment on the different topics:

Significant figures:

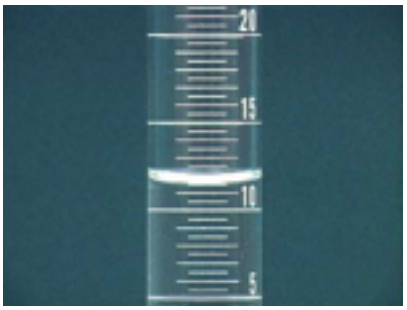
- You have probably covered significant figures in lecture, but because it is such a difficult concept for most students, it is being summarized again here. Significant figures are nothing more than the amount of digits we get from a measurement. The better a measurement is, the more significant figures you will have. This also means that for numbers that you don't measure, such as conversion factors, there are no significant figures. For example, if you measure a sample on a balance and the balance reads 2.543 g, then there are 4 significant figures. If you measure the same sample on a more sensitive balance, it may read 2.5438 g. The second measurement has 5 significant figures, and reflects a better measurement.

- An important note to make is that the very last digit in a measurement is always the least certain. Two people reading the same length on a ruler may see 1.24 cm vs. 1.25 cm. All three numbers are significant figures, but the last number has a bit of uncertainty. Both values are correct because it is expected that the last number is the uncertain one.
  To measure with significant figures, you count ALL digits. Each one is considered Each one is considered significant. For example, a ruler that reads 1.36 cm has 3 significant figures. A beaker with 12.52 mL of liquid has 4 significant figures. Scientific equipment has markings that let you read its measurement to a certain number of significant figures. The last value in your reading will ALWAYS be an estimate between the markings. This is why no two people will necessarily have the same exact number.

  Ruler example:

Here we see a ruler with markings every number, but none in between. The measurement between 6 and 7 looks to be a little before the half-way point. Acceptable answers for this measure of distance would be anywhere from 6.2-6.4.

- Volume example: When you read volumes in glassware, you read a point called the meniscus. When you add liquid to glassware, the interface between the air and the liquid being measured bends to form a shape like a "U". This "U" shape is the meniscus. Always read the bottom of the meniscus so that it is at your eye level. The meniscus here is right around the 11.5 marking. Possible answers would be 11.49−11.52. You read a thermometer in the same way.



- To do calculations with significant figures, there are a number of rules to learn. Although painful, it is best to commit these to memory as soon as possible. There is a different set of rules for addition/subtraction and multiplication/division. In most cases you can use standard rounding rules. If the final number is a 5, we round that to the closest even number.

- In addition and subtraction, pick the number with the fewest decimal places. Use that same number of decimal places in your final answer. Examples: 12.0 + 12.13 = 24.1 0.02− 0.0032=0.02

- In multiplication and division, you need to determine which numbers are indeed significant. Remember that if a number starts with zeros, those aren't significant. Any other zeros are. Count all digits in the numbers. In your final answer, use as many significant figures as the number with the fewest digits. If you end up with an answer with zeros at the end, it is best to write that in scientific notation if the answer is ambiguous. Examples: 0.00352 X 125=0.440 143/0.02010=7110 = 7.11 X 10^3

Materials: Graduated cylinders, beakers, rulers, balances, thermometers, metal weight samples.

Procedure:

There are stations set up around the lab that you will visit. Read the equipment at each station and record your values on the data sheet. You can start with any station. When you are finished, do the calculations on the post−lab sheet.

<u>Station 1: Graduated cylinders</u>

Graduated cylinders are used to measure more exact volumes of liquid. They are thin glass tubes with markings up the side, they start at 0−mL and go up. These will show a meniscus, so be careful when you are reading them. Read and record the volumes on the graduated cylinders.

Station 2: Beakers

Beakers are cylindrical glass containers which are commonly used for crude measurements and mixing chemicals. Beakers come in many sizes, from less than 10−mL to over several liters! Read and record the volumes on the beakers.

Station 5: Thermometers

In science, we tend to use mercury or alcohol thermometers. We measure all of our chemicals based off the Celsius (oC) scale. Read and record the temperatures of the beakers of water set out.

Station 6: Balances

Balances are great for measuring the mass of objects. Use the balance to measure and record the mass (weigh) the metal weights.

Station 7: Rulers

Rulers prove a valuable device for measuring distance. Measure the object using the available rulers.

SIGNIFICANT FIGURES, CALCULATIONS, AND READING MEASUREMENTS PRE−LAB

Name:_____Date:_____Class:_____

After reading the introduction to this lab, answer the following questions to prepare you for the experiment. You may want to refer to your notes.

1. Significant figures. For the numbers below, state how many significant figures there are.

a. 4.0258 _____ b. 1.024 _____ c. 0.2600 _____

d. 1345.1 _____ e. 1000.1 _____

2. Calculations. For the following problems, calculate the answer using the correct number of significant figures.

a. 1.2 + 0.13 =_____ b. 1.2 x 0.13 =_____

c. 485.369 / 0.124 =_____ d. 0.0012 - 0.0008 =_____

e. [1.265 + 1.02] x 82 =_____

SIGNIFICANT FIGURES, CALCULATIONS, AND READING MEASUREMENTS POST-LAB

Partner(s):_____

Station 1: Graduated cylinders

a. Meniscus reading for graduated cylinder "A" _____mL

b. Meniscus reading for graduated cylinder "B" _____mL

Station 2: Beakers

a. Volume reading for beaker "A" _____mL

b. Volume reading for beaker "B" _____mL

Station 3: Thermometers

a. Temperature reading for thermometer "A" _____oC

b. Temperature reading for thermometer "B" _____oC

Station 4: Balances

a. Mass of object "A" _____g

b. Mass of object "B" _____g

Station 5: Rulers

a. Length of object "A" _____cm

b. Length of object "B" _____cm